PARSL Observations at the Western Ground Site.
Part I: Radiation and the Atmospheric State

J. Mather (a), J. Comstock (a), T. Doherty (a), C. Flynn (a), D. Flynn (a), C. Long (a), R. Marchand (a), K. Widener (a), K. Laribee (b), Y. Li (b), G. Mace (b)

(a) Pacific Northwest National Laboratory, (b) University of Utah

Introduction

The Pacific Northwest National Laboratory Atmospheric Remote Sensing Laboratory (PARSL) is a mobile suite of instruments designed to measure the surface radiation budget and the atmospheric state.

PARSL instruments include broad and narrowband radiometers, a sky imager, two cloud radars (94 and 35 GHz), a cloud lidar, surface meteorology sensors and a balloon borne sounding system.

During CRYSTAL-FACE, PARSL was sponsored by the DOE Atmospheric Radiation Measurement (ARM) program to take part in CRYSTAL-FACE. PARSL was stationed at the western ground site in Everglades City. This site was located along the Gulf Coast, 120 km East of Miami and 150 km NNE of Key West.

PARSL Site at Everglades City, FL

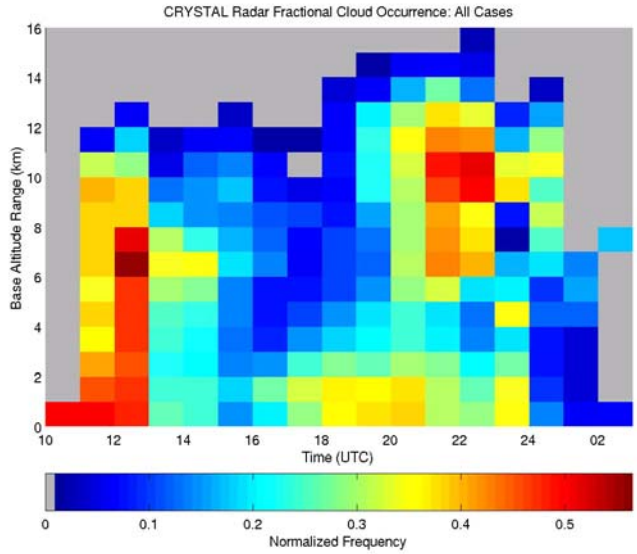
94GHz Antenna, TSI, and Aeribago

Prep for sonde launch

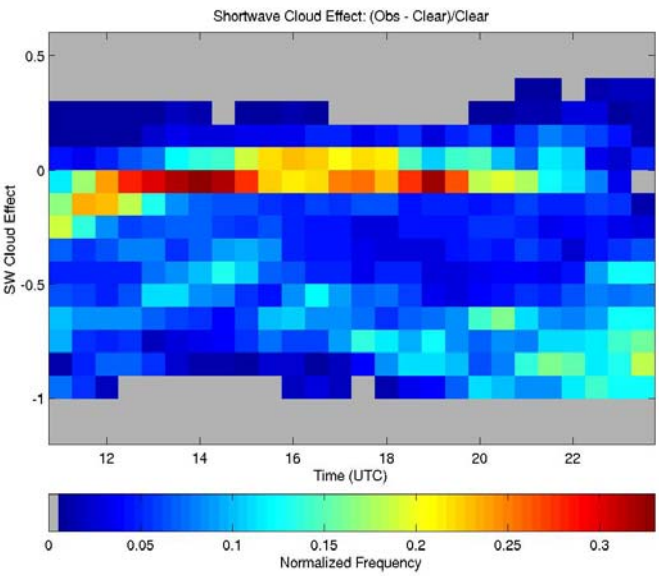
35 GHz Radar

PARSL Radiometers

The Diurnal Convection Cycle

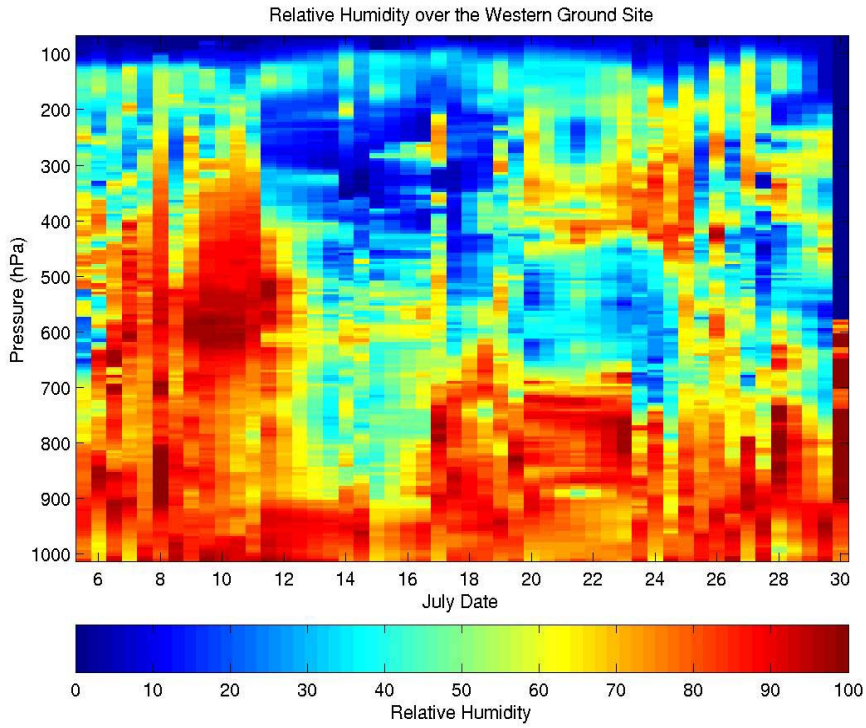


The sea-breeze driven convection in south Florida has a strong diurnal signature. The above figure depicts the frequency with which clouds occurred as a function of time of day and altitude as observed by the 94 GHz cloud radar. Cirrus are seen to be most common early in the morning and in the late afternoon. The early peak is associated with maritime convection while the latter peak is due to continental convection.

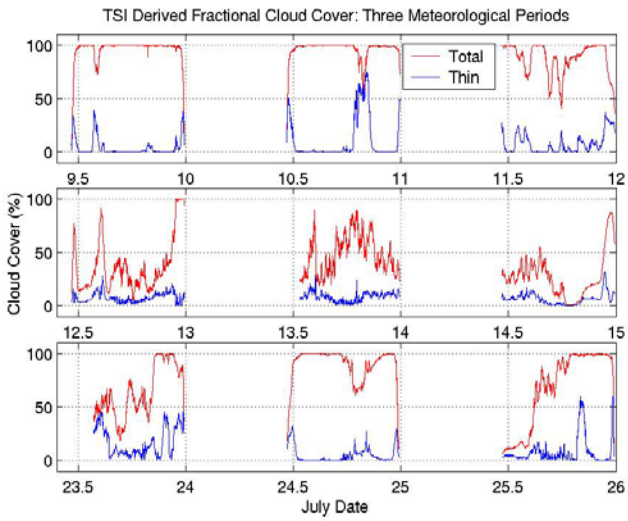


The figure to the left depicts the effect of these clouds on the shortwave radiation. As defined here, a cloud effect of 0 corresponds to the equivalent of clear skies while a cloud effect of –1 indicates virtually no shortwave reaches the ground. The strongest shortwave effect is seen to occur in the late afternoon, coincident with the continental deep convection.

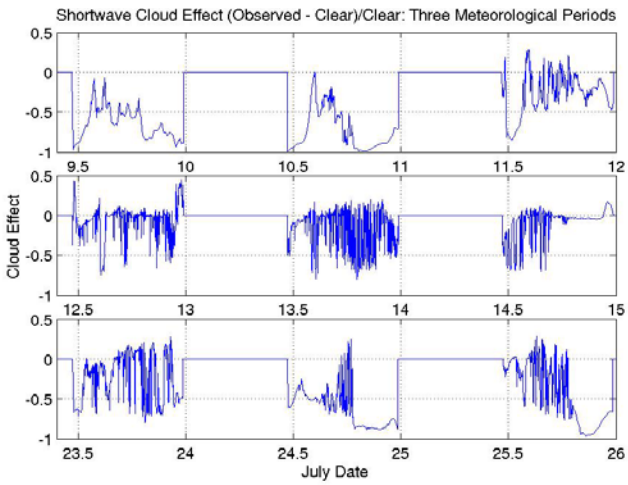
Meteorological Regimes During CRYSTAL



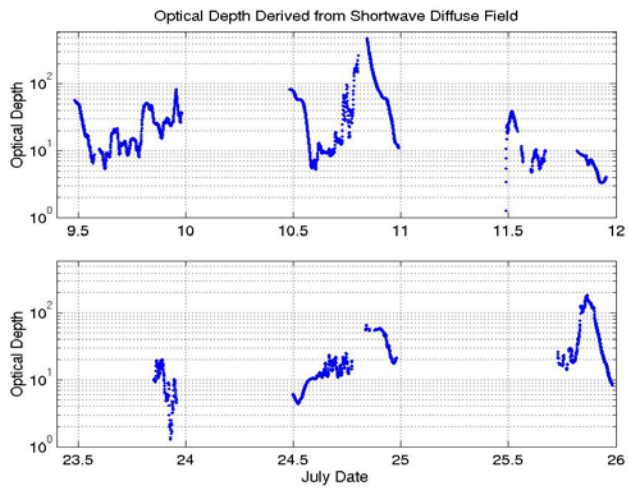
During CRYSTAL-FACE, south Florida experienced 3-4 distinct periods, each with different convective characteristics. Transitions between these periods on July 12, 17, and 25 are evident in the above plot of Relative Humidity taken from PARSL sonde data. The characteristics of these periods are shown in the plots below of TSI Cloud fraction, the shortwave cloud effect, and the shortwave cloud optical depth derived from the shortwave diffuse flux. The optical depth was only calculated for overcast conditions.



The Total Sky Imager (TSI) is a hemispheric viewing camera. It is used here to determine the fractional sky cover for portions of three periods during the experiment with distinct meteorological and convective characteristics.



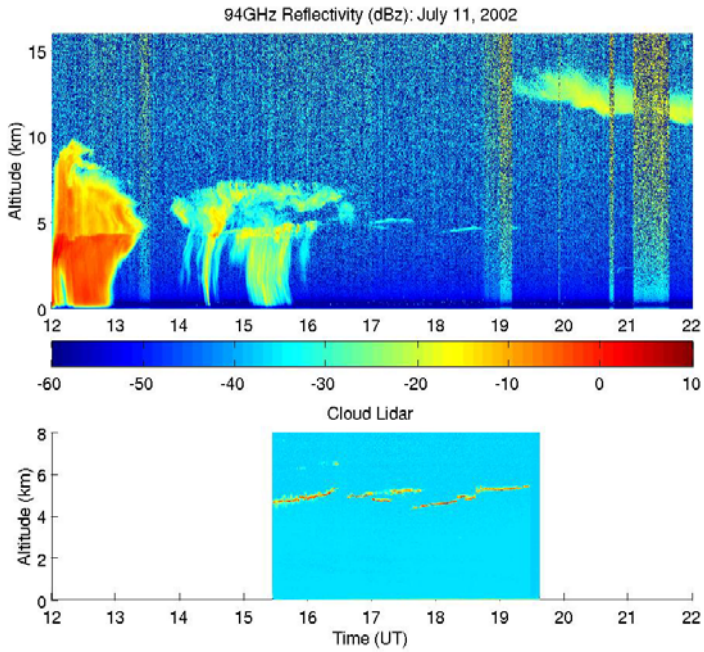
During the first period, morning maritime convection was common. During the second, deep convection was largely suppressed in southern Florida. During the third period, afternoon continental convection was common. Upper level northeasterly flow during this third period often advected anvils over the western ground site.



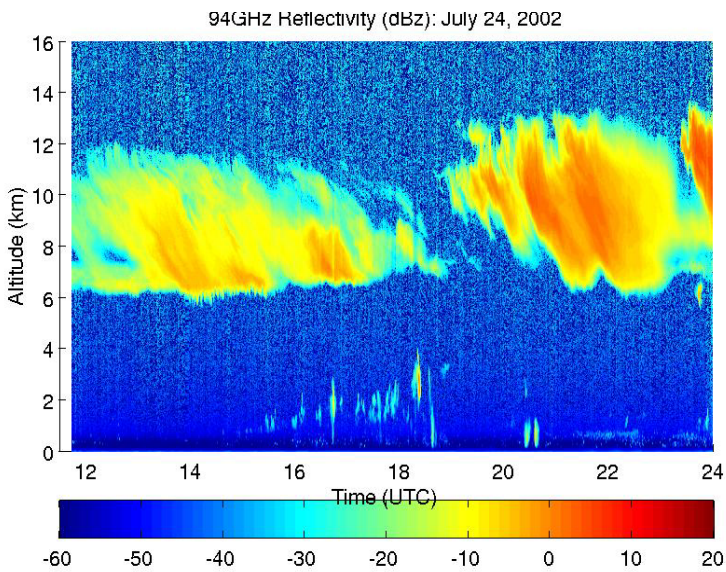
For overcast periods only, we have Applied a technique for calculating the Cloud optical depth from broadband Diffuse shortwave fluxes. This technique Was developed by Chuck Long and Jim Barnard at PNNL.

Cloud Radar and Lidar Images

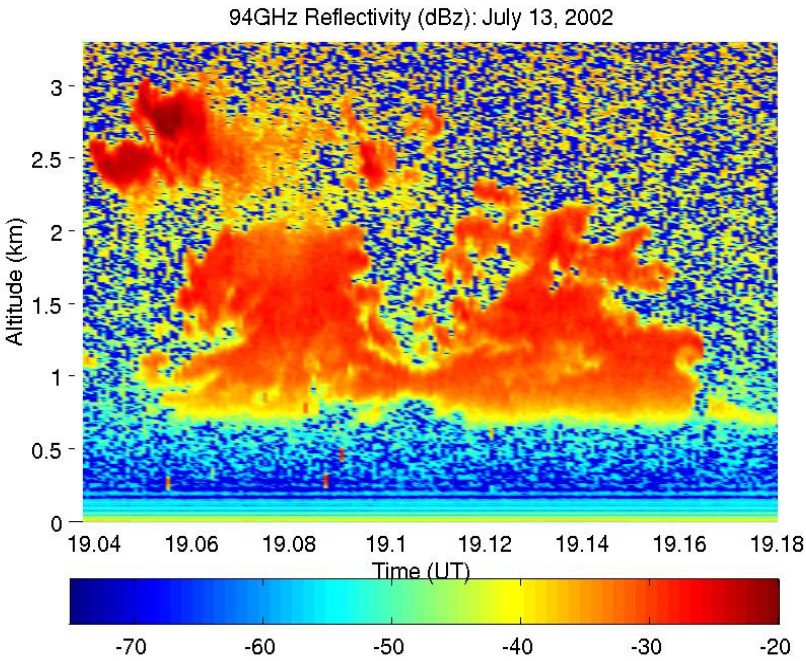
During CRYSTAL-FACE, the PARSL 94 GHz radar was Operated over 150 hours. Clouds were observed above 7 km approximately 40% of the time. Convective cores passed over the site on several occasions including 7/21 and 7/25. On 7/24, the site was under anvil cirrus most of the day. Operation of the cloud lidar was limited to the first week of the experiment.



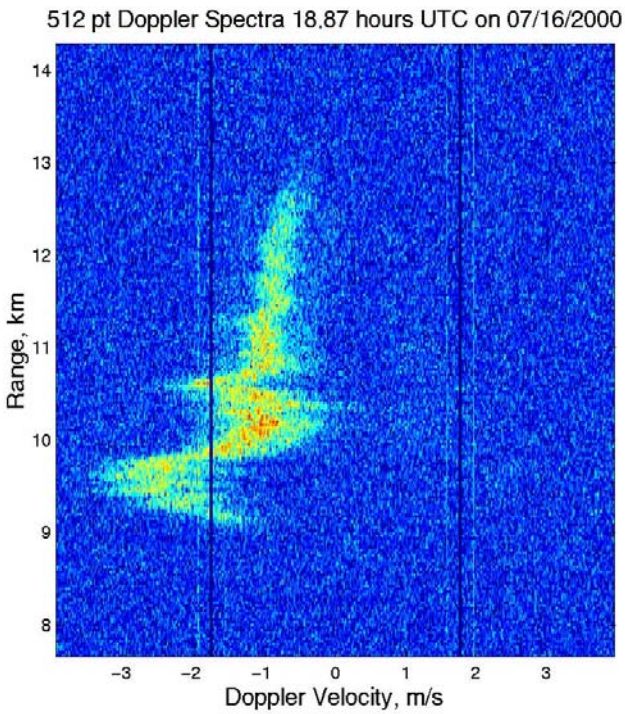
94 GHz Cloud Radar and Lidar data from July 11.



94 Ghz Radar data from July 24.



The PARSL radars are capable of very high temporal and spatial resolution. Shown here is a full resolution image of shallow cumulus.



During periods of particular interest such as aircraft over-flights, I/Q data are saved allowing the generation of detailed Doppler velocity spectra such as the example shown below from 7/16.

Conclusions

During the CRYSTAL-FACE experiment, PARSL observed a variety of convective clouds at the western ground site in Everglades City. This ground based data set will be a very useful addition to the aircraft data obtained during CRYSTAL. The radar-derived cloud properties as well as the surface radiation data clearly show the timing of the diurnal convective cycle. The radar data also provides details regarding the levels at which cirrus outflow typically occur. Although CRYSTAL-FACE was only a one month experiment, the south Florida area experienced several distinct meteorological regimes during this period. The PARSL sondes as well as the surface meteorological sensors (not shown in this presentation) show the transition between these periods. Meanwhile, cloud characteristics obtained from the radar and broadband radiometers change along with the meteorological forcing. Thus, the PARSL data set will provide an important context for CRYSTAL-FACE.

Corresponding author address:

Dr. James Mather, Pacific Northwest National Laboratory
PO Box 999, MS K9-24
Richland, WA 99352

Jim.Mather@pnl.gov